LECTURE 13-15: EXERCISES

All exercises should be performed in R. The solution should contain: i) PDF file ii) R code file. PDF should contain a specification of an exercise (the exercise specification in this file is probably not sufficient - You need to add some more assumptions), short description of different functions (only for the ones implemented by You) used in the R file, as well as attractive presentation of results (plots, tables). Please mail it to me when you are ready. Official deadline is: 22.02.2010. Please use your imagination!

(1) Perform a stochastic simulation of discrete random-walk process in 1d. Assume limited number of steps (e.g. number of steps, $N = 1000$).

(2) Perform a stochastic simulation of discrete random-walk process in 1d. Assume limited space (e.g. number of possible space states $N = 1000$) and assume that the last space state is connected also with the first one (e.g. $Neighbours(n = N) = \{0, N - 1\}$). Method: Markov chains.

(3) Perform a stochastic simulation of dimerisation process (described by the equations):

$$\begin{aligned} k1 : 2P &\rightarrow P_2 \\ k2 : P_2 &\rightarrow 2P \end{aligned}$$

Assume the same constants as on the lecture, but test the influence of $k2$ (e.g. by $\pm 50\%$ assuming uniform distribution of $k2$). variation:Method: Gillespie+Stochastic Petrinet.

(4) Perform a stochastic simulation of dimerisation process (described by the equations):

$$\begin{aligned} k1 : 2P &\rightarrow P_2 \\ k2 : P_2 &\rightarrow 2P \end{aligned}$$

Assume the same constants as on the lecture, but test the influence of cell volume variation assuming cell volumes are following normal distribution $Norm(\mu = 10^{-14}, \sigma = 10^{-14})$. Method: Gillespie+Stochastic Petrinet.

(5) Perform a stochastic simulation of a Michaelis-Menten kinetics:

$$\begin{aligned} k1 : S + E &\rightarrow SE \\ k2 : SE &\rightarrow S + E \\ k3 : SE &\rightarrow P + E \end{aligned}$$

Use the following conditions: $V = 10^{-15} dm^3$, $S_{init} = 5 \times 10^{-7} mol \times dm^{-3}$, $E_{init} = 2 \times 10^{-7} mol \times dm^{-3}$, $SE_{init} = P_{init} = 0$, $k1 = 10^{-6}$, $k_2 = 10^{-4}$, $k_3 = 0.1$. Method: Gillespie+Stochastic Petrinet.

(6) According to Kemeny, Snell, and Thompson[1] the Land of Oz is blessed by many things, but not by good weather. They never have two nice days in a row. If they have a nice day, they are just as likely to have snow as rain the next day. If they have snow or rain, they have an even chance of having the same the next day. If there is change from snow or rain, only half of the time is this a change to a nice day. If we assume that we start with sunny weather, propose a program which calculates the distribution of a weather for any given day. Method: Markov chains.

[1] J. G. Kemeny, J. L. Snell, G. L. Thompson, Introduction to Finite Mathematics, 3rd ed. (Englewood Cliffs, NJ: Prentice-Hall, 1974).